Appendix D

Life Cycle Cost Estimate Analysis Sheets

Retrieval option 1

Life-Cycle Cost (LCC) Analysis

(ALL COST X1000)

						2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
						0	1	2	3	4	5	6	7	8	9	10	11
						1.000	1.028	1.057	1.086	1.117	1.148	1.180	1.213	1.247	1.282	1.318	1.355
						Pre-Concept Design	CD-0	Prelim Design	Final Design	Construction		Start-up	Operations			DD&D	Closeout
						10/1/02 - 9/30/03	10/1/02 - 10/1/04	10/1/04- 9/30/05	10/1/05- 2/28/07	3/01/07-2/28/09		3/1/09-3/1/10	3/1/10-2/28/13			3/1/13- 8/31/14	9/1/14- 12/31/14
Other Project Cost (OPC)		*min*	*mean*	*max*	expected value	Total Cost											
OPC																	
Conceptual Design, Project Mgt, & Permitting		13,725	21,213	28,701	21,213	21,213	2,121	2,121	6,364	8,835	1,771						
Testing and Start-up		4,735	7,318	9,902	7,318	7,343						6,098	1,244				
Total OPC (unescalated)			28,531			28,555	2,121	2,121	6,364	8,835	1,771	-	6,098	1,244	-	-	-
plus escalation of			2,489			2,491	185	185	555	771	155	-	532	109	-	-	-
plus contingency of			21,147			21,165	1,572	1,572	4,717	6,549	1,313	-	4,520	922	-	-	-
Total OPC including escalation, mgt reserve, & contingency						$ 52,212	$ 3,879	$ 3,879	$ 11,636	$ 16,155	$ 3,239	$ -	$ 11,151	$ 2,275	$ -	$ -	$ -
TEC																	
ESH&Q		8,890	13,740	18,590	13,740	13,740					5,723	6,870	1,147				
Project mgt		6,176	9,546	12,915	9,546	9,546					3,976	4,773	797				
Construction, Equip, G&A & Procurement		78,470	121,283	164,096	121,283	121,283					50,515	60,642	10,127				
Total TEC (unescalated)			144,569			144,569	-	-	-	-	60,213	72,284	12,072	-			-
plus escalation of			15,996			15,996	-	-	-	-	6,662	7,998	1,336	-	-	-	-
plus contingency of			78,921			78,921	-	-	-	-	32,871	39,461	6,590	-	-	-	-
Total TEC including escalation, mgt reserve, contingency						$ 239,486	$ -	$ -	$ -	$ -	$ 99,746	$ 119,743	$ 19,997	$ -	$ -	$ -	$ -
Total Project Cost (TPC)																	
TPC unescalated			173,100			173,124	2,121	2,121	6,364	8,835	61,984	72,284	18,170	1,244	-	-	-
plus escalation of			18,485			18,487	185	185	555	771	6,817	7,998	1,868	109	-	-	-
plus contingency of			100,069			100,087	1,572	1,572	4,717	6,549	34,184	39,461	11,110	922	-	-	-
Total TPC including esc, mgt res, contingency			$ 291,654			$ 291,698	$ 3,879	$ 3,879	$ 11,636	$ 16,155	$ 102,985	$ 119,743	$ 31,148	$ 2,275	$ -	$ -	$ -
discount factor @ OMB discount rate of		4.20%					1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
Discounted Annual Cost						$ 243,474	$ 3,879	$ 3,722	$ 10,717	$ 14,279	$ 87,358	$ 97,479	$ 24,334	$ 1,706	$ -	$ -	$ -	$ -
Operations	2080 hr-shif	*min*	*mean*	*max*	expected value												
Tangible Costs						158,302	-	-	-	-	-	-	32,071	32,969	40,687	41,826	10,749	-
Managerial		2,246	2,808	3,510	2,855	13,853							2,807	2,885	3,561	3,660	941	
Supervision		8,986	11,232	14,040	11,419	55,413							11,226	11,541	14,242	14,641	3,763	
Labor (Production)		3,395	4,243	5,304	4,314	20,934							4,241	4,360	5,380	5,531	1,421	
(Maintenance)		1,432	1,591	2,307	1,684	8,172							1,656	1,702	2,100	2,159	555	
Maintenance of Equipment		3,743	4,159	6,030	4,401	21,357							4,327	4,448	5,489	5,643	1,450	
Diesel		51	63	79	64	313							63	65	80	83	21	
Grout		28	35	44	35	172							35	36	44	45	12	
Consumables		3,715	4,644	5,805	4,722	22,913							4,642	4,772	5,889	6,054	1,556	
Utilities(Power&Water)		256	321	401	326	1,582							320	329	407	418	107	
Disposal (m3)		2,192	2,740	3,426	2,786	13,520							2,739	2,816	3,475	3,572	918	
Analytical		12	15	19	15	74							15	15	19	20	5	
Operations subtotal						158,302	-	-	-	-	-	-	32,071	32,969	40,687	41,826	10,749	-
plus Operations Contingency @		5.0%	15.0%	45.0%	22%	34,299	-	-	-	-	-	-	6,949	7,143	8,815	9,062	2,329	-
Total Operations (w/contingency)						192,601	-	-	-	-	-	-	39,020	40,112	49,502	50,888	13,078	-
discount factor @ OMB discount rate of		4.20%					1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
Discounted Annual Cost						$ 132,986	$ -	$ -	$ -	$ -	$ -	$ -	$ 30,484	$ 30,075	$ 35,619	$ 35,141	$ 8,667	$ -
		min	*mean*	*max*	expected value												
Post Operations																	
Decommission		2,770	3,462	4,328	3,520	3,520										2,921	598
Decontamination/surveillance		1,385	1,731	2,164	1,760	1,760										1,461	299
Demolition		11,078	13,848	17,310	14,079	14,079										11,685	2,393
Post-Operations Subtotal		15,233	19,041	23,801	19,358	19,358	-	-	-	-	-	-	-	-	-	16,067	3,291
plus Escalation						6,278	-	-	-	-	-	-	-	-	-	5,110	1,168
plus Post-Operations Contingency @		15%	40%	58%	38%	9,656	-	-	-	-	-	-	-	-	-	7,977	1,680
Total Post-Operations (w/ escalation & contingency)						35,293	-	-	-	-	-	-	-	-	-	29,155	6,139
discount factor @ OMB discount rate of		4.20%					1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
Discounted Annual Cost						$ 23,225	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 19,321	$ 3,904
Total Cost							2,121	2,121	6,364	8,835	61,984	72,284	50,241	34,213	40,687	41,826	26,817	3,291
Cumulative Total LCC						350,785	2,121	4,243	10,606	19,442	81,426	153,710	203,951	238,164	278,851	320,677	347,494	350,785
Total Cost (w/mgt reserve, & contingency)							3,879	3,879	11,636	16,155	102,985	119,743	70,168	42,387	49,502	50,888	42,233	6,139
Cumulative Total LCC						519,593	3,879	7,757	19,393	35,548	138,532	258,276	328,443	370,830	420,333	471,221	513,454	519,593
discount factor @ OMB discount rate of		4.20%					1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
Discounted Annual Cost							3,879	3,722	10,717	14,279	87,358	97,479	54,819	31,780	35,619	35,141	27,988	3,904
Cumulative Discounted LCC						$ 406,685	$ 3,879	$ 7,601	$ 18,318	$ 32,597	$ 119,954	$ 217,434	$ 272,252	$ 304,033	$ 339,652	$ 374,793	$ 402,781	$ 406,685

Retrieval option 2

Life-Cycle Cost (LCC) Analysis

(ALL COST X1000)		min	mean	max	expected value	Total Cost
Other Project Cost (OPC)						
OPC						
Conceptual Design, Project Mgt. & Permitting		$12,528	$19,364	$26,199	$19,364	19,393
Testing and Start-up		$4,310	$6,661	$9,013	$6,661	6,681
Total OPC (unescalated)			$26,025			26,074
plus escalation of			$2,269			2,273
plus contingency of			$19,155			19,191
Total OPC including escalation, mgt reserve, & contingency						47,538
TEC						
ESH&Q		$8,120	$12,551	$16,981	$12,551	12,551
Project mgt		$5,638	$8,714	$11,789	$8,714	8,714
Construction, Equip, G&A & Procurement		$72,099	$111,436	$150,774	$111,436	111,436
Total TEC (unescalated)			$132,701			132,701
plus escalation of			$14,689			14,689
plus contingency of			$73,629			73,629
Total TEC including escalation, mgt reserve, contingency						221,019
Total Project Cost (TPC)						
TPC unescalated			$158,726			158,775
plus escalation of			$16,958			16,963
plus contingency of			$92,783			92,819
Total TPC including esc, mgt res, contingency			$268,467			268,557
discount factor @ OMB discount rate of		4.20%				
Discounted Annual Cost						$ 223,880
Operations	2080 hr-shif	min	mean	max	expected value	
Tangible Costs						149,600
Managerial		2,246	$2,808	$3,510	$2,855	13,853
Supervision		7,638	$9,547	$11,934	$9,706	47,101
Labor (Production)		3,960	$4,950	$6,188	$5,033	24,423
(Maintenance)		1,095	$1,217	$1,764	$1,288	6,249
Maintenance of Equipment		3,407	$3,786	$5,489	$4,006	19,441
Diesel		62	$77	$97	$78	381
Grout		28	$35	$44	$35	172
Consumables		3,698	$4,622	$5,778	$4,699	22,804
Utilities(Power&Water)		256	$321	$401	$326	1,581
Disposal (m3)	320.5	2,192	$2,740	$3,426	$2,786	13,520
Analytical		12	$15	$19	$15	74
Operations subtotal						149,600
plus Operations Contingency @		2.0%	12.0%	30.0%	15%	21,941
Total Operations (w/contingency)						171,541
discount factor @ OMB discount rate of		4.20%				
Discounted Annual Cost						$ 124,679
		min	mean	max	expected value	
Post Operations						
Decommission		2,540	$3,175	$3,968	$3,227	3,227
Decontamination/surveillance		1,270	$1,587	$1,984	$1,614	1,614
Demolition		10,158	$12,698	$15,873	$12,910	12,910
Post-Operations Subtotal		$13,968	$17,460	$21,825	$17,751	17,751
plus Escalation						5,757
plus Post-Operations Contingency @		15%	40%	58%	38%	8,855
Total Post-Operations (w/ escalation & contingency)						32,362
discount factor @ OMB discount rate of		4.20%				
Discounted Annual Cost						$ 21,297
Total Cost						
Cumulative Total LCC						$326,125
Total Cost (w/mgt reserve, & contingency)						
Cumulative Total LCC						$472,460
discount factor @ OMB discount rate of		4.20%				
Discounted Annual Cost						
Cumulative Discounted LCC						$369,855

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	0	1	2	3	4	5	6	7	8	9	10	11
	1.000	1.028	1.057	1.086	1.117	1.148	1.180	1.213	1.247	1.282	1.318	1.355
	Pre-Conceptional Design	CD-0	Prelim Design	Final Design	Construction		Start-up	Operations			DD&D	Closeout
	10/1/02 - 9/30/03	10/1/02 - 10/1/04	10/1/04- 9/30/05	10/1/05- 2/28/07	3/01/07-2/28/09		3/1/09-3/1/10	3/1/10-2/28/13			3/1/13-8/31/14	9/1/14- 12/31/14
	1,936	1,936	5,809	8,065	1,646		1,132	5,549				
	1,936	1,936	5,809	8,065	1,646	-	1,132	5,549	-	-	-	-
	169	169	506	703	143	-	99	484	-	-	-	-
	1,425	1,425	4,276	5,936	1,211	-	833	4,084	-	-	-	-
	3,530	3,530	10,591	14,704	3,001	-	2,065	10,117	-	-	-	-
					5,227	6,275	1,048					
					3,629	4,357	728					
					46,413	55,718	9,305					
					55,270	66,350	11,081	-	-	-	-	-
					6,118	7,345	1,227	-	-	-	-	-
					30,666	36,814	6,148	-	-	-	-	-
					92,054	110,509	18,455	-	-	-	-	-
	1,936	1,936	5,809	8,065	56,916	66,350	12,213	5,549	-	-	-	-
	169	169	506	703	6,262	7,345	1,325	484	-	-	-	-
	1,425	1,425	4,276	5,936	31,878	36,814	6,981	4,084	-	-	-	-
	3,530	3,530	10,591	14,704	95,055	110,509	20,520	10,117	-	-	-	-
	1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
	$ 3,530	$ 3,388	$ 9,755	$ 12,997	$ 80,631	$ 89,962	$ 16,031	$ 7,585	$ -	$ -	$ -	$ -
							30,308	31,157	38,450	39,527	10,158	-
							2,807	2,885	3,561	3,660	941	
							9,542	9,810	12,106	12,445	3,198	
							4,948	5,086	6,277	6,453	1,658	
							1,266	1,301	1,606	1,651	424	
							3,939	4,049	4,997	5,137	1,320	
							77	79	98	101	26	
							35	36	44	45	12	
							4,620	4,749	5,861	6,025	1,548	
							320	329	406	418	107	
							2,739	2,816	3,475	3,572	918	
							15	15	19	20	5	
	-	-	-	-	-	-	30,308	31,157	38,450	39,527	10,158	-
	-	-	-	-	-	-	4,445	4,570	5,639	5,797	1,490	-
	-	-	-	-	-	-	34,753	35,726	44,089	45,324	11,648	-
	1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
	$ -	$ -	$ -	$ -	$ -	$ -	$ 27,151	$ 26,786	$ 31,724	$ 31,298	$ 7,719	$ -
											2,679	549
											1,339	274
											10,715	2,195
	-	-	-	-	-	-	-	-	-	-	14,733	3,018
	-	-	-	-	-	-	-	-	-	-	4,686	1,071
	-	-	-	-	-	-	-	-	-	-	7,315	1,540
	-	-	-	-	-	-	-	-	-	-	26,734	5,629
	1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 17,717	$ 3,580
	1,936	1,936	5,809	8,065	56,916	66,350	42,521	36,705	38,450	39,527	24,892	3,018
	1,936	3,873	9,682	17,747	74,662	141,013	183,534	220,239	258,689	298,216	323,108	326,125
	3,530	3,530	10,591	14,704	95,055	110,509	55,273	45,843	44,089	45,324	38,382	5,629
	3,530	7,061	17,652	32,356	127,411	237,920	293,193	339,036	383,125	428,449	466,831	472,460
	1	1	1	1	1	1	1	1	1	1	2	2
	3,530	3,388	9,755	12,997	80,631	89,962	43,182	34,372	31,724	31,298	25,436	3,580
	$ 3,530	$ 6,918	$ 16,673	$ 29,670	$ 110,301	$ 200,263	$ 243,446	$ 277,817	$ 309,541	$ 340,840	$ 366,275	$ 369,855

Retrieval option 3

Life-Cycle Cost (LCC) Analysis

						2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
						0	1	2	3	4	5	6	7	8	9	10	11
						1.000	1.028	1.057	1.086	1.117	1.148	1.180	1.213	1.247	1.282	1.318	1.355
						Pre-Conceptional Design	CD-0	Prelim Design	Final Design	Construction	Start-up	Operations				DD&D	Closeout
							10/1/02 - 9/30/04	10/1/04-9/30/05	10/1/05-2/28/07	3/01/07-2/28/09	3/1/09-3/1/10	3/1/10-2/28/13				3/1/13-8/31/14	9/1/14-12/31/14
(ALL COST X1000)																	
Other Project Cost (OPC)		min	mean	max	expected value	Total Cost											
OPC																	
Conceptual Design, Project Mgt, & Permitting		12,528	19,364	26,199	19,364	19,364	1,936	1,936	5,810	8,065	1,617						
Testing and Start-up		4,310	6,661	9,013	6,661	6,681						5,549	1,132				
Total OPC (unescalated)			26,025			26,045	1,936	1,936	5,810	8,065	1,617	5,549	1,132	-			
plus escalation of			2,269			2,102	-	169	507	703	141	484	99	-			
plus contingency of			19,334			19,349	1,438	1,438	4,316	5,992	1,201	4,122	841	-			
Total OPC including escalation, mgt reserve, & contingency						47,496	3,374	3,543	10,633	14,760	2,959	10,155	2,072	-			
TEC																	
ESH&Q		8,120	12,551	16,981	12,551	12,551					5,227	6,275	1,048				
Project mgt		5,638	8,714	11,789	8,714	8,714					3,629	4,357	728				
Construction, Equip, G&A & Procurement		72,903	112,678	152,454	112,678	112,678				-	46,930	56,339	9,409				
Total TEC (unescalated)			133,943			133,943	-	-	-	-	55,787	66,971	11,184	-	-	-	-
plus escalation of			14,790			14,790	-	-	-	-	6,160	7,395	1,235	-	-	-	-
plus contingency of			75,065			75,065	-	-	-	-	31,265	37,533	6,268	-	-	-	-
Total TEC including escalation, mgt reserve,	[redacted]					223,798	-	-	-	-	93,212	111,899	18,687	-	-	-	-
Total Project Cost (TPC)																	
TPC unescalated			159,967			159,988	1,936	1,936	5,810	8,065	57,404	66,971	16,733	1,132	-	-	-	-
plus escalation of			17,059			16,892	-	169	507	703	6,301	7,395	1,719	99	-	-	-	-
plus contingency of			94,400			94,415	1,438	1,438	4,316	5,992	32,466	37,533	10,390	841	-	-	-	-
Total TPC including esc, mgt res, contingency			271,426			271,294	3,374	3,543	10,633	14,760	96,171	111,899	28,842	2,072	-	-	-	-
discount factor @ OMB discount rate of		4.20%					1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
Discounted Annual Cost						226,372	3,374	3,400	9,793	13,046	81,578	91,094	22,533	1,554	-	-	-	-
Operations	2080 hr-shift	min	mean	max	expected value												
Tangible Costs	600					151,316	-	-	-	-	-	-	30,656	31,514	38,891	39,980	10,275	-
Managerial		1,747	2,184	2,730	2,220	10,775							2,183	2,244	2,769	2,847	732	
Supervision		9,360	11,700	14,625	11,895	57,722							11,694	12,022	14,836	15,251	3,920	
Labor (Production)		2,829	3,536	4,420	3,595	17,445							3,534	3,633	4,484	4,609	1,185	
(Maintenance)		1,432	1,591	2,307	1,684	8,172							1,656	1,702	2,100	2,159	555	
Maintenance of Equipment		3,407	3,786	5,489	4,006	19,441							3,939	4,049	4,997	5,137	1,320	
Diesel		84	105	131	106	516							104	107	133	136	35	
Grout		28	35	44	35	172							35	36	44	45	12	
Consumables		3,551	4,439	5,548	4,513	21,898							4,436	4,561	5,628	5,786	1,487	
Utilities(Power&Water)		256	321	401	326	1,581							320	329	406	418	107	
Disposal (m3)	329.5	2,192	2,740	3,426	2,786	13,520							2,739	2,816	3,475	3,572	918	
Analytical		12	15	19	15	74							15	15	19	20	5	
Operations subtotal						151,316	-	-	-	-	-	-	30,656	31,514	38,891	39,980	10,275	-
plus Operations Contingency @		0	0	0	0	22,193	-	-	-	-	-	-	4,496	4,622	5,704	5,864	1,507	-
Total Operations (w/contingency)						173,509	-	-	-	-	-	-	35,152	36,136	44,595	45,844	11,782	-
discount factor @ OMB discount rate of		4.20%					1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
Discounted Annual Cost						126,109	-	-	-	-	-	-	27,463	27,094	32,088	31,657	7,808	-
		min	mean	max	expected value													
Post Operations																		
Decommission		2,559	3,199	3,999	3,253	3,253											2,700	553
Decontamination/surveillance		1,280	1,600	2,000	1,626	1,626											1,350	276
Demolition		10,238	12,797	15,997	13,011	13,011											10,799	2,212
Post-Operations Subtotal		14,077	17,596	21,996	17,890	17,890									-	-	14,848	3,041
plus Escalation						5,802	-	-	-	-	-	-	-	-	-	-	4,723	1,080
plus Post-Operations Contingency @		0	0	0	0	4,541	-	-	-	-	-	-	-	-	-	-	3,751	790
Total Post-Operations (w/ escalation & contingency)						28,233	-	-	-	-	-	-	-	-	-	-	23,322	4,911
discount factor @ OMB discount rate of		0					1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
Discounted Annual Cost						18,579	-	-	-	-	-	-	-	-	-	-	15,456	3,123
Total Cost							1,936	1,936	5,810	8,065	57,404	66,971	47,389	32,646	38,891	39,980	25,123	3,041
Cumulative Total LCC						329,193	1,936	3,872	9,682	17,747	75,151	142,122	189,511	222,157	261,048	301,029	326,152	329,193
Total Cost (w/mgt reserve, & contingency)							3,374	3,543	10,633	14,760	96,171	111,899	63,994	38,208	44,595	45,844	35,104	4,911
Cumulative Total LCC						473,036	3,374	6,917	17,550	32,310	128,481	240,380	304,374	342,582	387,177	433,021	468,125	473,036
discount factor @ OMB discount rate of		4.20%					1.000	1.042	1.086	1.131	1.179	1.228	1.280	1.334	1.390	1.448	1.509	1.572
Discounted Annual Cost							3,374	3,400	9,793	13,046	81,578	91,094	49,996	28,647	32,088	31,657	23,264	3,123
Cumulative Discounted LCC						371,060	3,374	6,775	16,568	29,613	111,191	202,285	252,281	280,928	313,016	344,673	367,937	371,060

Appendix E

Risk Analysis Tables

Risk Analysis Tables

Table E-1. Risk analysis work sheet for Alternative 1.

#	Risk Statement	Initial Probability of Occurrence	Initial Consequence of Occurrence	Initial Risk Factor and Level	Handling Strategy and Response Actions
1	A significant amount of radiological and hazardous material is released to the environment (i.e., that reaches a collocated worker and/or member of the public) due to a breach in the retrieval confinement that is caused by a loss of control of the remote-controlled retrieval equipment or an intentional act.	Unlikely 0.3	Critical 0.8	Moderate 0.24	Design collision avoidance systems or add barriers
2	Contamination leaks from the primary confinement due to the presence of a leak path and a loss or reverse of ventilation requiring limited facility and/or equipment decontamination, schedule delays, and increased cost.	Unlikely 0.4	Significant 0.6	Moderate 0.24	Provide compartments outside of primary confinement to limit contaminated areas
3	A fire occurs inside the retrieval confinement area causing damage to equipment and the facilities and resulting in additional cost and schedule delays to investigate, make repairs, and restart.	Likely 0.5	Significant 0.6	High 0.30	Design fire suppression systems
4	Retrieval equipment is seriously damaged due to a subsidence or operator error, cost increases, and schedule delays.	Unlikely 0.3	Significant 0.6	Moderate 0.18	Provide redundant equipment.
5	Retrieval equipment is inoperable for a short period due to a subsidence, operator error or a breakdown, small cost increase and small schedule delays.	Likely 0.5	Marginal 0.3	Moderate 0.15	Design Features to allow for repairs and recovery.
6	The Agencies require the waste under (and around) excepted large objects and highly radioactive (i.e., remote-handled) waste to be retrieved because it cannot be demonstrated that the risk posed by this waste is acceptable for the protection of human health and the environment resulting in increased project cost and duration.	Likely 0.5	Significant 0.7	High 0.35	Get Agency buy in early in the design.

Table E-1. (continued).

#	Risk Statement	Initial Probability of Occurrence	Initial Consequence of Occurrence	Initial Risk Factor and Level	Handling Strategy and Response Actions
7	The Agencies require the highly radioactive (i.e., remote-handled) waste to be retrieved because it cannot be demonstrated that the risk posed by this waste is acceptable for the protection of human health and the environment resulting in increased project cost and duration.	Likely 0.5	Significant 0.7	High 0.35	Get Agency buy in early in the design.
8	The Agencies require materials less than or equal to 100 nCi/g TRU to be placed in a RCRA compliant (i.e., engineered) landfill. The project would incur significantly greater costs, increased storage space requirements, and reauire longer proiect duration.	Unlikely 0.4	Critical 0.8	Moderate 0.32	Establish closure design criteria early in the design
9	The Stage III retrieval confinement exhaust treatment is inadequate for addressing VOCs released by the excavation and retrieval activity resulting in a release above regulatory limits, NOVs, and fines. Schedule delays and addtional costs are incurred to correct the deficiency.	Unlikely 0.3	Significant 0.7	Moderate 0.21	Verify design assumptions early in the design
10	The Pit 7 location is dfferent that what is current documentation indcates.	Likely 0.5	Marginal 0.2	Moderate 0.10	Field verify Pit 7 location early in design.
11	A waiver allowing the use of a fabric-skinned structure for secondary confinement is not obtained from the Authority having Jurisdiction. A noncombustible material must, therefore, be used resulting in increased design, material, construction, and final dsposition costs. The duration of construction is significantly increased.	Unlikely 0.4	Significant 0.5	Moderate 0.20	Seek an early waiver for use of the fabric skin
12	The retrieval area is classified as an occupied space and IBC code requirements for maximum area are imposed. The retrieval area is required to be divided by fire walls. Increased construction costs, schedule and increased DD&D labor costs and schedule.	Unlikely 0.4	Significant 0.6	Moderate 0.24	Seek early approval for the unoccupied assumption
13	The HVAC system causes an over pressure of the primary confinement boundary and releases contamination to other portions of the retrieval building.	Unlikely 0.4	Critical 0.8	Moderate 0.32	Provide pressure relief equipment
	Total of Risk Factors			3.20	

Table E-2. Risk analysis work sheet for Alternative 2

#	Risk Statement	Initial Probability of Occurrence	Initial Consequence of Occurrence	Initial Risk Factor and Level	Handling Strategy and Response Actions
1	A significant amount of radiological and hazardous material is released to the environment (i.e., that reaches a collocated worker and/or member of the public) due to a breach in the retrieval confinement that is caused by a loss of control of the remote-controlled retrieval equipment or an intentional act.	Likely 0.7	Critical 0.8	High 0.56	Design collision avoidance systems or add barriers
2	Contamination leaks from the primary confinement due to the presence of a leak path and a loss or reverse of ventilation requiring limited facility and/or equipment decontamination, schedule delays, and increased cost.	Unlikely 0.4	Significant 0.6	Moderate 0.24	Provide compartments outside of primary confinement to limit contaminated areas
3	A fire occurs inside the retrieval confinement area causing damage to equipment and the facilities and resulting in additional cost and schedule delays to investigate, make repairs, and restart.	Likely 0.6	Significant 0.6	High 0.36	Design fire suppression systems
4	Retrieval equipment is seriously damaged due to a subsidence or operator error, cost increases, and schedule delays.	Unlikely 0.4	Significant 0.6	Moderate 0.24	Provide redundant equipment.
5	Retrieval equipment is inoperable for a short period due to a subsidence, operator error or a breakdown, small cost increase and small schedule delays.	Likely 0.5	Marginal 0.3	Moderate 0.15	Design features to allow for repairs and recovery.
6	The Agencies require the waste under (and around) excepted large objects and highly radioactive (i.e., remote-handled) waste to be retrieved because it cannot be demonstrated that the risk posed by this waste is acceptable for the protection of human health and the environment resulting in increased project cost and duration.	Likely 0.5	Significant 0.6	High 0.30	Get Agency buy in early in the design.
7	The Agencies require the highly radioactive (i.e., remote-handled) waste to be retrieved because it cannot be demonstrated that the risk posed by this waste is acceptable for the protection of human health and the environment resulting in increased project cost and duration.	Likely 0.5	Significant 0.6	High 0.30	Get Agency buy in early in the design.

Table E-2. (continued).

#	Risk Statement	Initial Probability of Occurrence	Initial Consequence of Occurrence	Initial Risk Factor and Level	Handling Strategy and Response Actions
8	The Agencies require materials less than or equal to 100 nCi/g TRU to be placed in a RCRA compliant (i.e., engineered) landfill. The project would incur significantly greater costs, increased storage space requirements, and require longer project duration.	Unlikely 0.4	Critical 0.8	Moderate 0.32	Establish closure design criteria early in the design
9	The Stage III retrieval confinement exhaust treatment is inadequate for addressing VOCs released by the excavation and retrieval activity resulting in a release above regulatory limits, NOVs, and fines. Schedule delays and addtional costs are incurred to correct the deficiencv.	Unlikely 0.3	Significant 0.7	Moderate 0.21	Verify design assumptions early in the design
10	The Pit 7 location is dfferent that what is current documentation indcates.	Likely 0.5	Marginal 0.4	Moderate 0.20	Field verify Pit 7 location early in design.
11	A waiver allowing the use of a fabric-skinned structure for secondary confinement is not obtained from the Authority having Jurisdiction. A noncombustible material must, therefore, be used resulting in increased design, material, construction, and final dsposition costs. The duration of construction is significantly increased.	Unlikely 0.4	Significant 0.5	Moderate 0.20	Seek an early waiver for use of the fabric skin
12	The retrieval area is classified as an occupied space and IBC code requirements for maximum area are imposed. The retrieval area is required to be divided by fire walls. Increased construction costs, schedule and increased DD&D labor costs and schedule.	Unlikely 0.4	Significant 0.6	Moderate 0.24	Seek early approval for the unoccupied assumption
13	The HVAC system causes an over pressure of the primary confinement boundary and releases contamination to other portions of the retrieval building.	Unlikely 0.4	Critical 0.8	Moderate 0.32	Provide pressure relief equipment
	Total of Risk Factors			3.64	

Table E-3. Risk analysis work sheet for Alternative 3

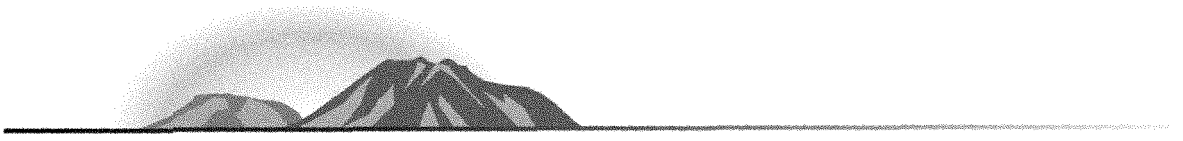
#	Risk Statement	Initial Probability of Occurrence	Initial Consequence of Occurrence	Initial Risk Factor and Level	Handling Strategy and Response Actions
1	A significant amount of radiological and hazardous material is released to the environment (i.e., that reaches a collocated worker and/or member of the public) due to a breach in the retrieval confinement that is caused by a loss of control of the remote-controlled retrieval equipment or an intentional act.	Likely 0.7	Critical 0.8	High 0.56	Design collision avoidance systems or add barriers
2	Contamination leaks from the primary confinement due to the presence of a leak path and a loss or reverse of ventilation requiring limited facility and/or equipment decontamination, schedule delays, and increased cost.	Unlikely 0.4	Significant 0.6	Moderate 0.24	Provide compartments outside of primary confinement to limit contaminated areas
3	A fire occurs inside the retrieval confinement area causing damage to equipment and the facilities and resulting in additional cost and schedule delays to investigate, make repairs, and restart.	Likely 0.6	Significant 0.6	High 0.36	Design fire suppression systems
4	Retrieval equipment is seriously damaged due to a subsidence or operator error, cost increases, and schedule delays.	Unlikely 0.4	Significant 0.6	Moderate 0.24	Provide redundant equipment.
5	Retrieval equipment is inoperable for a short period due to a subsidence, operator error or a breakdown, small cost increase and small schedule delays.	Likely 0.5	Marginal 0.3	Moderate 0.15	Design features to allow for repairs and recovery.
6	The Agencies require the waste under (and around) excepted large objects and highly radioactive (i.e., remote-handled) waste to be retrieved because it cannot be demonstrated that the risk posed by this waste is acceptable for the protection of human health and the environment resulting in increased project cost and duration.	Likely 0.5	Significant 0.6	High 0.30	Get Agency buy in early in the design.
7	The Agencies require the highly radioactive (i.e., remote-handled) waste to be retrieved because it cannot be demonstrated that the risk posed by this waste is acceptable for the protection of human health and the environment resulting in increased project cost and duration.	Likely 0.5	Significant 0.6	High 0.30	Get Agency buy in early in the design.

Table E-3. (continued).

#	Risk Statement	Initial Probability of Occurrence	Initial Consequence of Occurrence	Initial Risk Factor and Level	Handling Strategy and Response Actions
8	The Agencies require materials less than or equal to 100 nCi/g TRU to be placed in a RCRA compliant (i.e., engineered) landfill. The project would incur significantly greater costs, increased storage space requirements, and require longer project duration.	Unlikely 0.4	Critical 0.8	Moderate 0.32	Establish closure design criteria early in the design
9	The Stage III retrieval confinement exhaust treatment is inadequate for addressing VOCs released by the excavation and retrieval activity resulting in a release above regulatory limits, NOVs, and fines. Schedule delays and addtional costs are incurred to correct the deficiencv.	Unlikely 0.3	Significant 0.7	Moderate 0.21	Verify design assumptions early in the design
10	The Pit 7 location is dfferent that what is current documentation indcates.	Likely 0.5	Marginal 0.4	Moderate 0.20	Field verify Pit 7 location early in design.
11	A waiver allowing the use of a fabric-skinned structure for secondary confinement is not obtained from the Authority having Jurisdiction. A noncombustible material must, therefore, be used resulting in increased design, material, construction, and final dsposition costs. The duration of construction is significantly increased.	Unlikely 0.4	Significant 0.5	Moderate 0.20	Seek an early waiver for use of the fabric skin
12	The retrieval area is classified as an occupied space and IBC code requirements for maximum area are imposed. The retrieval area is required to be divided by fire walls. Increased construction costs, schedule and increased DD&D labor costs and schedule.	Unlikely 0.4	Significant 0.6	Moderate 0.24	Seek early approval for the unoccupied assumption
13	The HVAC system causes an over pressure of the primary confinement boundary and releases contamination to other portions of the retrieval building.	Unlikely 0.4	Critical 0.8	Moderate 0.32	Provide pressure relief equipment
	Total of Risk Factors			3.64	

Appendix F

Pit 9 Retrieval Option Selection Meeting Record



Pit 9 Retrieval Project Retrieval Alternative Selection Meeting Record

June 16,2003
1200-1530 hours

TSA Classroom B
Idaho Falls, Idaho

AND

June 17,2003
0830-1600 hours

TSA Classroom F
Idaho Falls, Idaho

Facilitated by:
William "Buck" West
526-1314
westwh@inel.gov

MEETING OBJECTIVE

Assess and rate how well each of the Stage III options respond to the specified selection criteria.

ATTENDEES

June 16,2003

NAME	PHONE	E-MAIL	MS
Wilkins, David E	526-7495	DWW	3920
Davies, Steven A	526-4789	SDV	3920
Austad, Stephanie	526-2054	AUS	3920
Bryan, Jeff	526-1899	BRYANJD	3920
Helm, Brent	526-8056	BXH	3920

June 17,2003

NAME	PHONE	E-MAIL	MS
Austad, Stephanie	526-2054	AUS	3920
Borland, Mark W	526-3897	BORLMW	3920
Bryan, Jeff	526-1899	BRYANJD	3920
Guillen, Louis E	526-2705	GEL	3920
Hanson, Robert N	526-4606	HANSRN	3920
Helm, Brent	526-8056	BXH	3920
Hills, Steve	526-8347	HLL	3920
Horne, W Rick	526-5318	HRW	4201
Ireland, Frank W	526-4081	IRELFW	5312
Jensen, Scott A	526-0544	SAJ5	3920
Johnson, Darin	526-8982	JOHNDR	4212
Spaulding, Bryan C	526-1119	SPAUBC	2220
Wooley, Kelly A	526-4731	WLY	3920
Provided ranking after the meeting			
Barker, James W	526-3432	BARKJW	4201
Burton, Brent N	526-8695	BTB	3920
Peatross, Rodney G	526-8575	TRO	3920

ACTIONS AND CONCLUSIONS

Decision Criteria

Long-term effectiveness and reduction of TM&V (Weight = 0.100)

- Volume of irretrievable waste left in the pit (Weight = 0.017)
- Contamination Spread to Clean Overburden (Weight = 0.017)
- Contamination Spread within Waste (Weight = 0.017)
- Volume of Secondary Waste Generated (Weight = 0.017)
- Contamination Levels of Secondary Wastes (Weight = 0.017)
- Contamination Spread to Clean Underburden (Weight = 0.017)

Short-term Protection of human health and environment (Weight = 0.433)

- Protection from Plutonium Uptake (Weight = 0.108)
- Protection from Radiation (Weight = 0.108)
- Protection from Hazardous Chemicals (Weight = 0.108)
- Protection from Industrial Hazards (Weight = 0.108)

Technical Feasibility (Weight = 0.466)

- Designability (Weight = 0.047)
- Constructability (Weight = 0.047)
- Operability (Weight = 0.047)
- Reliability (Weight = 0.047)
- Flexibility (Weight = 0.047)
- Maintainability (Weight = 0.047)
- Inspectability (Weight = 0.047)
- Operation risk (cost) (Weight = 0.047)
- Deconability (Weight = 0.047)
- Transferability to other pits and trenches (Weight = 0.047)

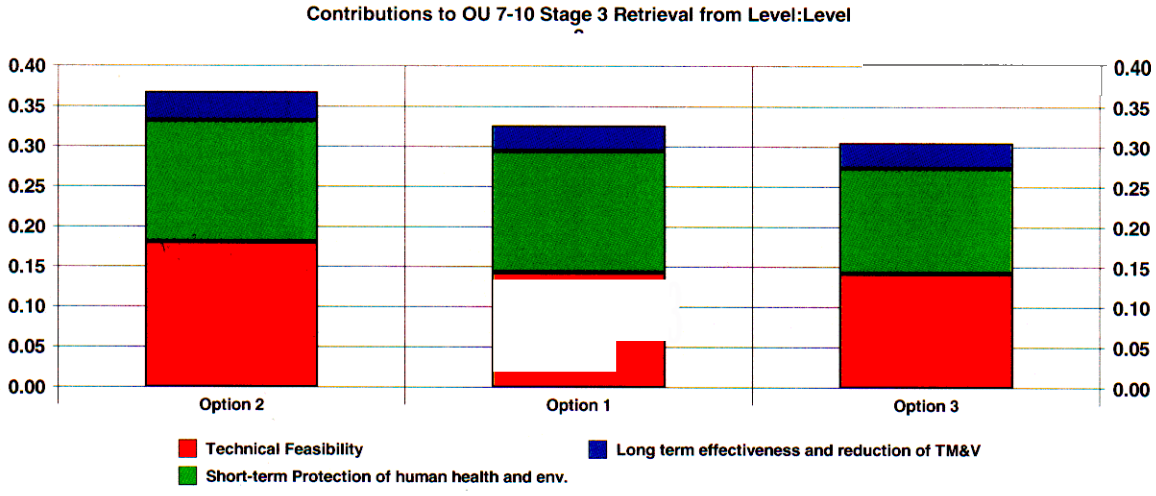
Option *Ranking*

The group's ranking of the three options for each of the twenty weighted criteria is as follows:

Option *2* Front-end Loader/Backhoe below grade excavation and waste return. (Overall score = *0.368)*

Option 1 Crane above grade excavation and waste return *with backhoe & box/hopper*[1]. (Overall score = *0.326)*

Option *3* Backhoe/boxes/forklift above grade excavation and waste return. (Overall score = *0.305)*



Based on the distribution of the group's scores Option *2* is always the best solution. The group included non-team engineers to provide a "fresh pair of eyes" to review the options. The consensus levels indicate the non-team engineers had about the same assessment of an option's response to the criteria as the team engineers.

Analysis of Results

The criteria were examined for how well they contributed to the selection of the preferred option. This examination focused on:

- Was there any discrimination between the options for a criterion?
- Was the rating group in consensus on their scores of the options?
- How much uncertainty is there in the scoring of the options against the criteria?
- How sensitive are the criteria to changes in their weights?

[1] Italicized portion of the option title was added during the morning discussion session to help complete the option description.

Non-Discriminating Criteria

Those criterion were all options were scored the same (when rounded to the nearest integer) indicated that the criterion was not a discriminator between the options. This resulted in the elimination of four criteria:

1. Contamination Levels of Secondary Wastes (Weight = 0.017)
2. Protection from Radiation (Weight = 0.108)
3. Flexibility (Weight = 0.047)
4. Contamination Spread within Waste (Weight = 0.017)

Score Consensus

The option scores exhibited a high degree of consensus for option 2, followed by options 3 and 1. Consensus scores were calculated using the Ventana Coefficient of Consensus (VCC). VCC is a measure of the agreement and disagreement on the group's rating. The smaller the spread compared to the possible range, the better the level of consensus. **A** value of 1.00 represents complete consensus while a value of 0.00 represents no consensus. The following table shows the consensus score for the three options.

Table 1. Ventana Coefficient of Consensus scores for each option.

Option	High	Low	Mean
Option 1	0.80	0.33	0.59
Option 2	1.00	0.42	0.76
Option 3	0.90	0.46	0.61

Individual criteriodoption scores were examined for those combinations where the group had the least amount of consensus on a score. Those cells that showed an approximate normal distribution, even though widely spread, were assumed to be normal disagreement between the participants. Cells where there was a bi-modal distribution were considered more of a concern. These cells tended to have the lowest VCC values within an option. Criterion/option combinations exhibiting a bi-modal distribution include:

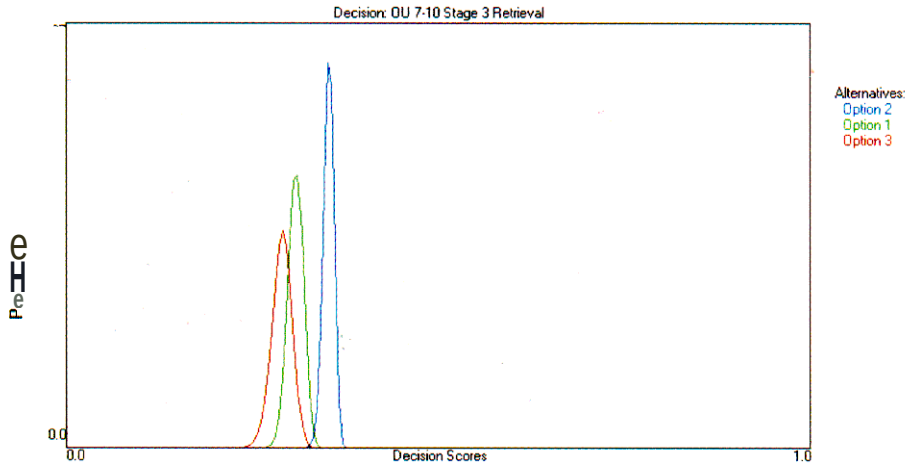
- Option 1
  - Volume of difficult to retrieve waste left in the pit (VCC = 0.43)
  - Deconability (VCC = 0.41)
  - Volume of Secondary Waste Generated (VCC = 0.33)
- Option 2
  - Contamination Spread within Waste (VCC = 0.46)
  - Contamination Spread to Clean Underburden (VCC = 0.42)

- Option3
  - Operation risk (cost) (VCC = 0.41)
  - Designability (VCC = 0.4)

These criteriodoption combinations are discussion candidates to determine why the low level of consensus and the bi-modal distribution of the scores. The concern with these cells is that there is a possible split between how the team engineers view an option verses how the non-team engineers view the same option. However, because all scoring was done anonymously it is not possible to assess of this is a valid concern.

Decision Uncertainty

The group means and standard deviations for each criteriodoption combination were entered into the *Criterium Decision Plus*© software. Based on that information, the possible decision scores for each option were calculated along with the probability that the alternative could have that score.

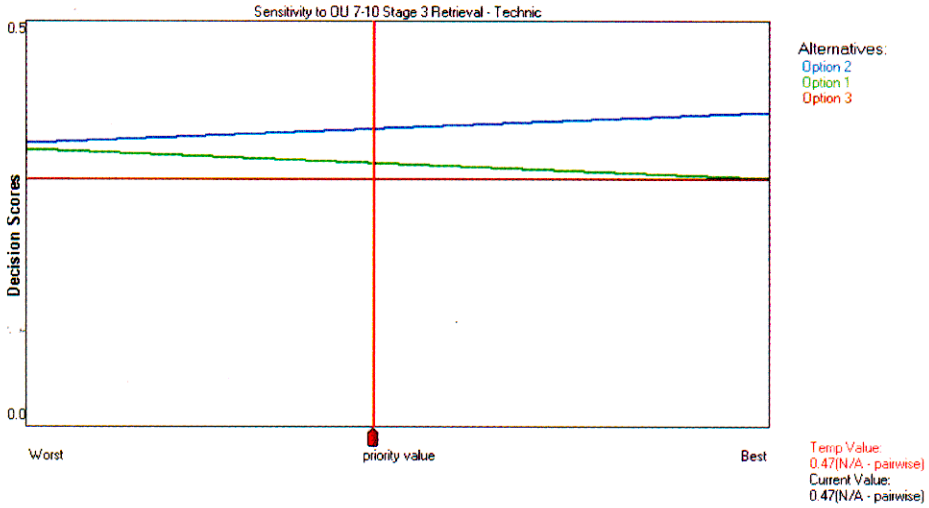


Probability of Option Scores Given Group Uncertainty In Scoring.

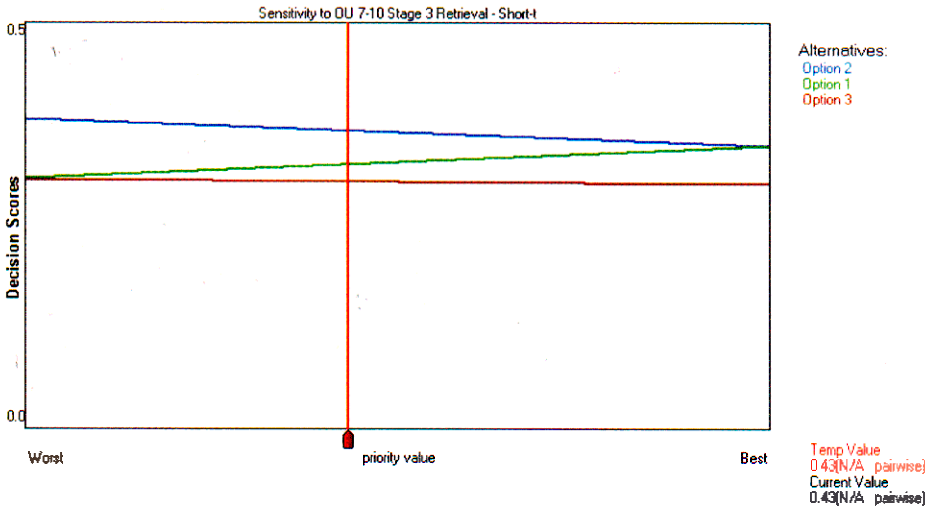
Sensitivity to Criteria Weight

Sensitivity analysis was conducted on the weights attached to each of the criteria. This analysis determines how much the weight will need to change in order to change the order of the options. The analysis was conducted using *Criterium Decision Plus*© software. For the purposes of the analysis the criteria were assumed to have a normal distribution for uncertainty in rating the options against the criteria.

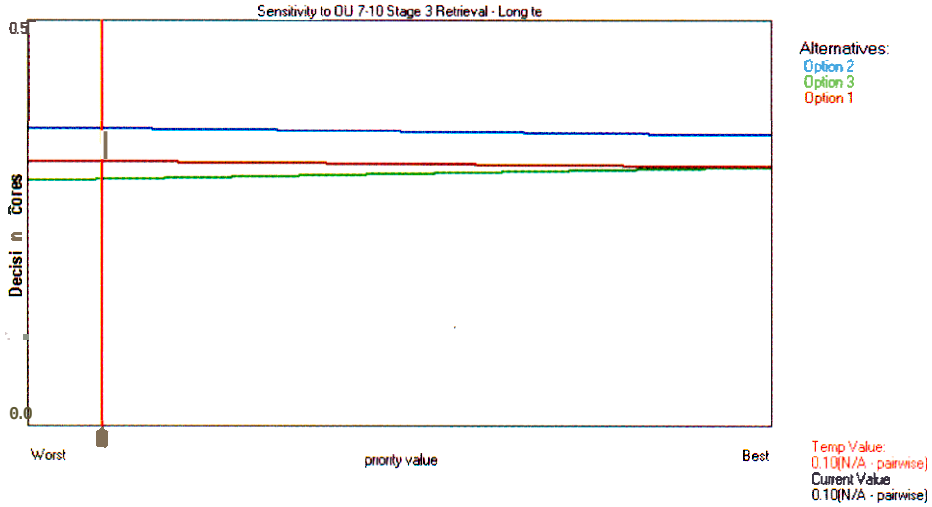
The option scores were very insensitive to the criteria weight to the extent that Option 2 could never be replaced as the top option by changing the weights of any of the criteria. Options 1 and 3 were sensitive to the criteria weights on only two (Inspectability and Maintainability) of the twenty criteria.



Sensitivity To **Technical Criteria Weights**



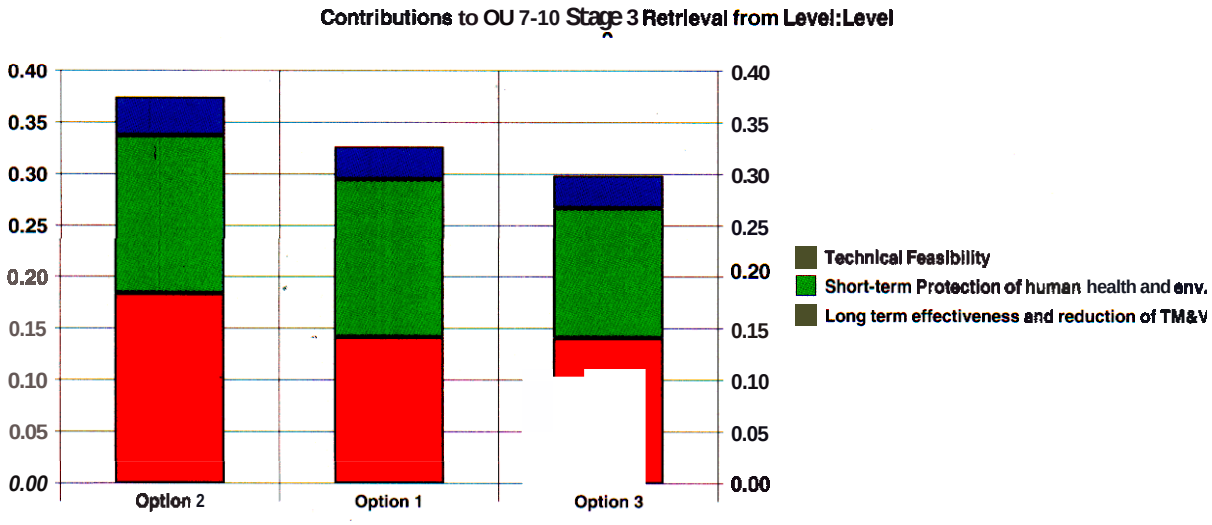
Sensitivity To **Short-Tern Protection *Of* Health And Environment Criteria Weights**



Sensitivity To Long-Tern Effectiveness Criteria Weights

Elimination Of Non-Discriminating Criteria

By eliminating the four non-discriminating criteria from the analysis (and recalculating the remaining criteria weights) **the** three options did not change relative position, but the decision scores (Option **2 =** 0.375, Option **1 = 0.327,** Option **3 = 0.299)** showed more separation between the options.



Uncertainty and sensitivity analysis did not change significantly with elimination of the four non-discriminating criteria.

MEETING PROCESS

On June 16, 2003, a group of five "decision makers" for the OU 7-10 project met to discuss, identify, and weigh decision criteria for Stage III retrieval options. Twenty-four draft criteria, within five top-level headings, were presented by Brent Helm and discussed by the group (see Appendix A). The draft criteria were based on CERCLA closure criteria.

Based on that discussion the top-level heading of "Availability of Services and Materials" was removed as criteria. The group then assigned weights to the top-level headings using a pair-wise comparison of each top-level criterion to each of the other top-level criterion. For each criterion pair, the group first decided which of the criterion was more important, and then on a 1-9 scale (with 1 meaning the criterion were equal in importance) how much more important that criterion was. *Criterium Decision Plus©* software was used to calculate the criterion weights. A consistency ratio of 0.050 was calculated by the software. The software recommends ratios of less than 0.10 for sound decisions. This ratio indicates the group was very consistent in their comparisons of the criteria.

Based on the low weight (0.050) for the top-level heading of "Schedule Effectiveness" that criterion was eliminated. With the elimination of that top-level criterion the consistency ratio improved to 0.005. The group then decided the weights for the sub-criteria within a top-level criterion should be held equal to each other. The end result was twenty criteria, within three top-level headings (see Decision Criteria section on page 6).

On June 17, 2003, a different team was convened to rate the three options against the decision criteria. The three options considered were:

Option 1 – Crane above grade excavation & waste return *with backhoe & box/hopper*[2].

Option 2 – Front-end Loader/Backhoe below grade excavation & waste return.

Option 3 – Backhoe/boxes/forklift above grade excavation & waste return.

During the morning session, each of the options were presented and discussed in detail. See Appendix B for graphic representations of each of the options. During the afternoon session each criterion was presented and discussed for clarity by the group. During the discussion, the facilitator recorded notes on each criterion describing what a good option would look like for that criterion (see page 30). At the end of each criterion discussion the group was asked to rate each of the options for that criterion.

The meeting used a computer-assisted facilitation processes using *Group Systems Meeting Room©* software. Each participant had access to a computer, linked with other computers in the room. Any ranking or scoring was done via the computers and the results were immediately available for review and discussion. Comments and scoring information were recorded anonymously. Any information entered into the computers, including ranking or scoring information, is part of the meeting record.

[2] Italicized portion of the option title was added during the morning discussion session to help complete the option description

The group was instructed to rate the options on a 1 to 7 scale. Within each criterion, they were to select the option that best addresses the criterion and rate it a 7. They were then to rate the remaining two options relative to that best option. If all the options respond to the criterion equally well (or equally poorly) then all three options were to be rated as a 7. The group was also instructed to "explain" their vote, especially if they rated an option low (1, 2 or 3) for a criterion.

After all the rating was completed the group reviewed some of the scores for consensus within the group (see Appendix C). No changes were made to the ratings as a result of the review. After the meeting, three participants who were not able to attend the meeting were later briefed and asked to rate the options.

Once all the ratings were completed, the mean rating value for each criteriodoption combination was entered into the *Criterium Decision Plus*© software to calculate the final option scores.

Appendix F1: Draft CERCLA Criteria

Type and Quantity of Residuals Remaining After Ret

- Contamination Spread to Clean Overburden
- Contamination Spread within Waste
- Volume of Secondary Waste Generated
- Contamination Levels of Secondary Wastes
- Contamination Spread to Clean Underburden

Schedule Effectiveness

- Design Schedule
- Procurement Schedule
- Construction Schedule
- Operation Schedule

Worker Protection

- Protection from Plutonium Uptake
- Protection from Radiation
- Protection from Hazardous Chemicals
- Protection from Industrial Hazards

Technical Feasibility

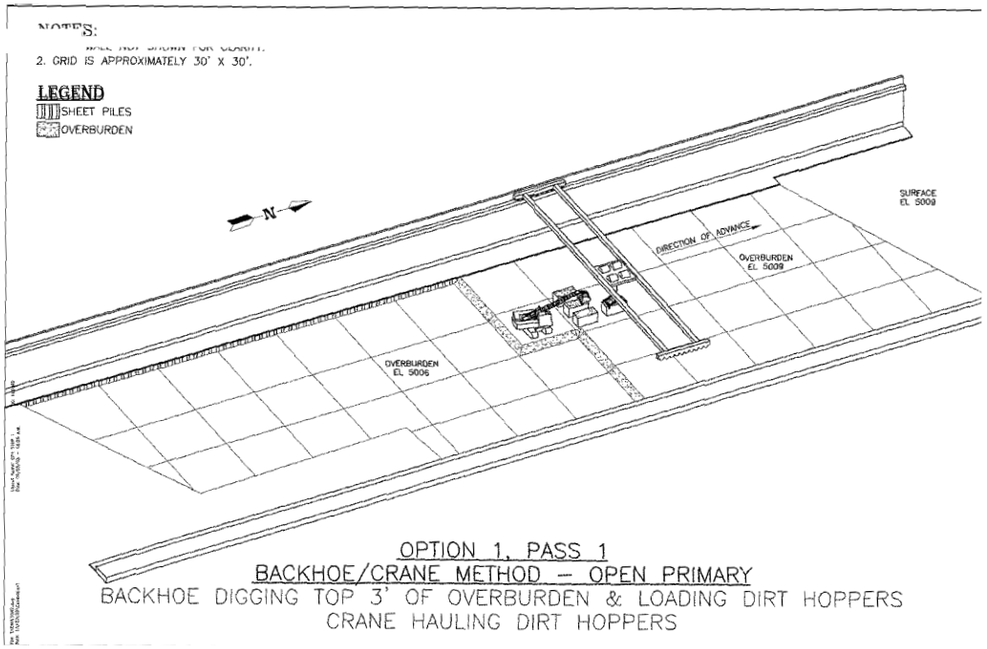
- Designability
- Constructability
- Operability
- Reliability
- Flexibility
- Maintainability
- Inspectability
- Confinability
- Deconability

Availability of Services and Materials

- Availability of Workers
- Availability of Equipment

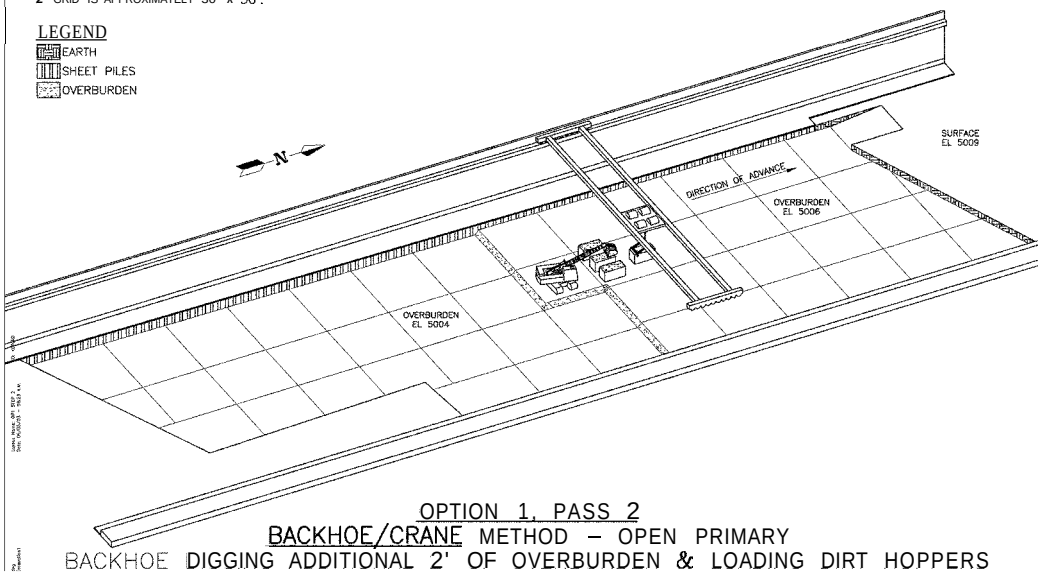
Appendix F2

Graphic Representation Of The Three Alternatives For Stage III Retrieval.



NOTES:
1. EAST WALL NOT SHOWN FOR CLARITY
2 GRID IS APPROXIMATELY 30' X 30'.

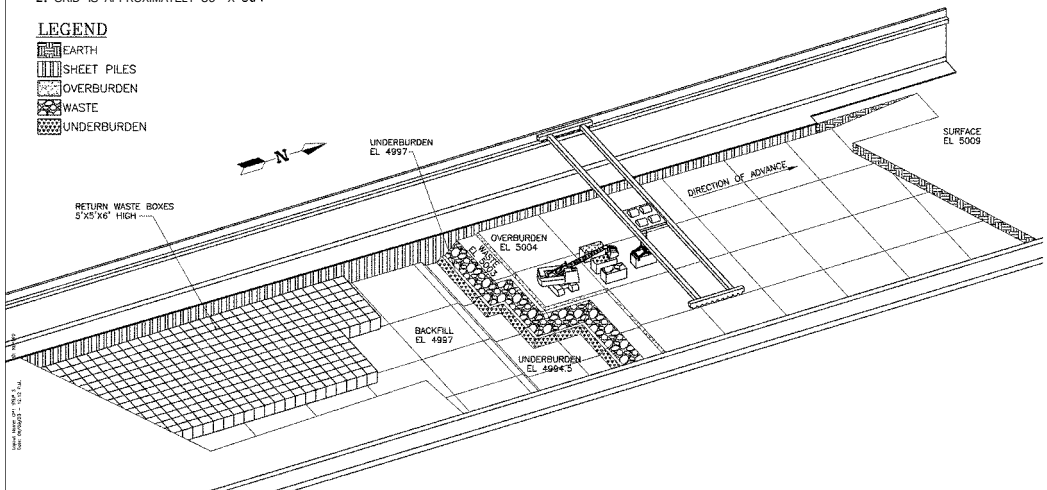
LEGEND
EARTH
SHEET PILES
OVERBURDEN



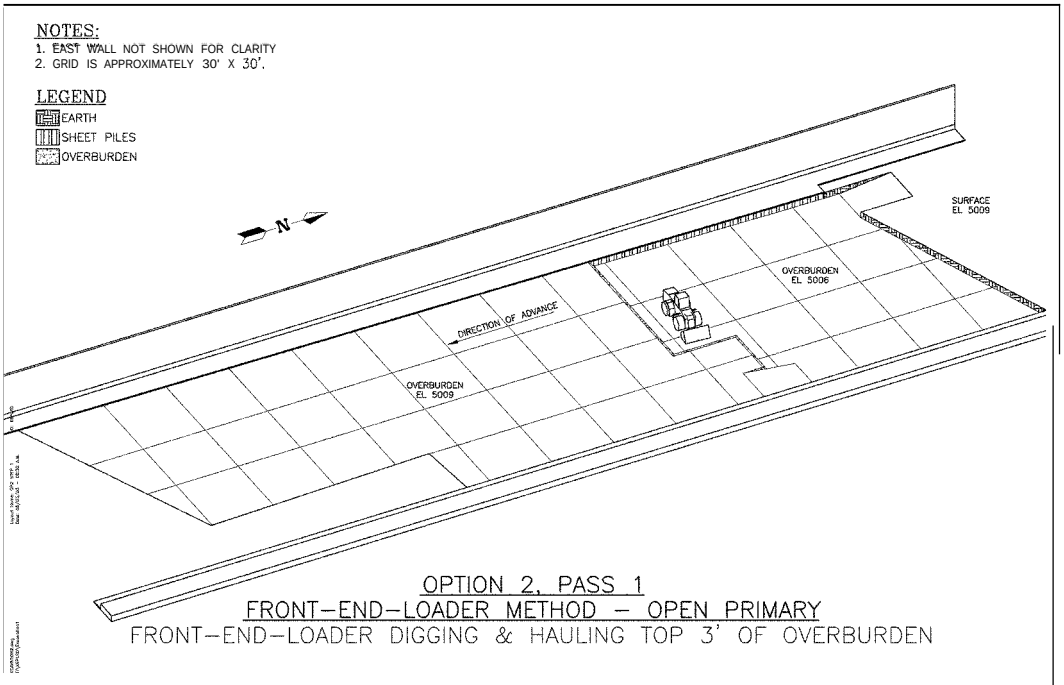
OPTION 1, PASS 2
BACKHOE/CRANE METHOD – OPEN PRIMARY
BACKHOE DIGGING ADDITIONAL 2' OF OVERBURDEN & LOADING DIRT HOPPERS
CRANE HAULING DIRT HOPPERS

NOTES:
1 EAST WALL NOT SHOWN FOR CLARITY
2. GRID IS APPROXIMATELY 30' X 30'.

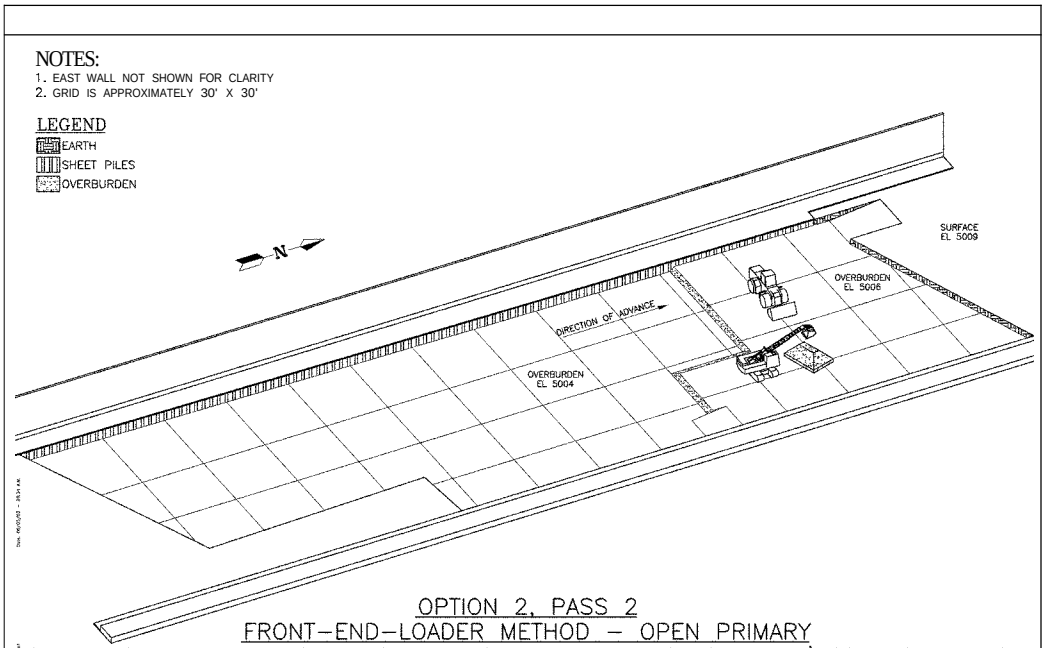
LEGEND
EARTH
SHEET PILES
OVERBURDEN
WASTE
UNDERBURDEN



OPTION 1, PASS 3
BACKHOE/CRANE METHOD – OPEN PRIMARY
BACKHOE DIGGING OVERBURDEN, WASTE & UNDERBURDEN, LOADING BOXES
CRANE HAULING BOXES



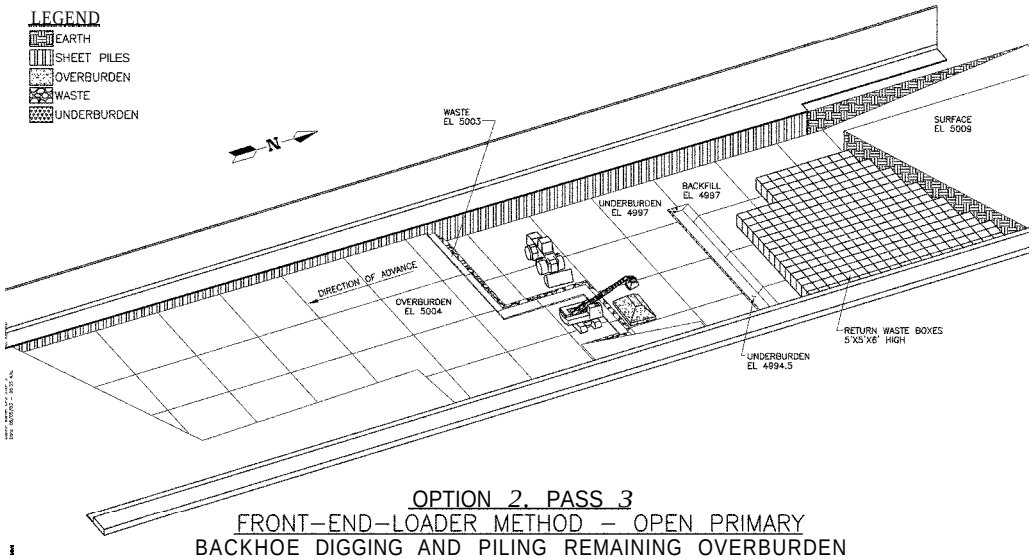
OPTION 2, PASS 1
FRONT-END-LOADER METHOD - OPEN PRIMARY
FRONT-END-LOADER DIGGING & HAULING TOP 3' OF OVERBURDEN



OPTION 2, PASS 2
FRONT-END-LOADER METHOD - OPEN PRIMARY
BACKHOE DIGGING & FRONT-END-LOADER HAULING ADDITIONAL 2' OF OVERBURDEN

NOTES:
1 EASi WALL NOT SHOWN FOR CLARITY
2. GRID IS APPROXIMATELY 30' x 30'.

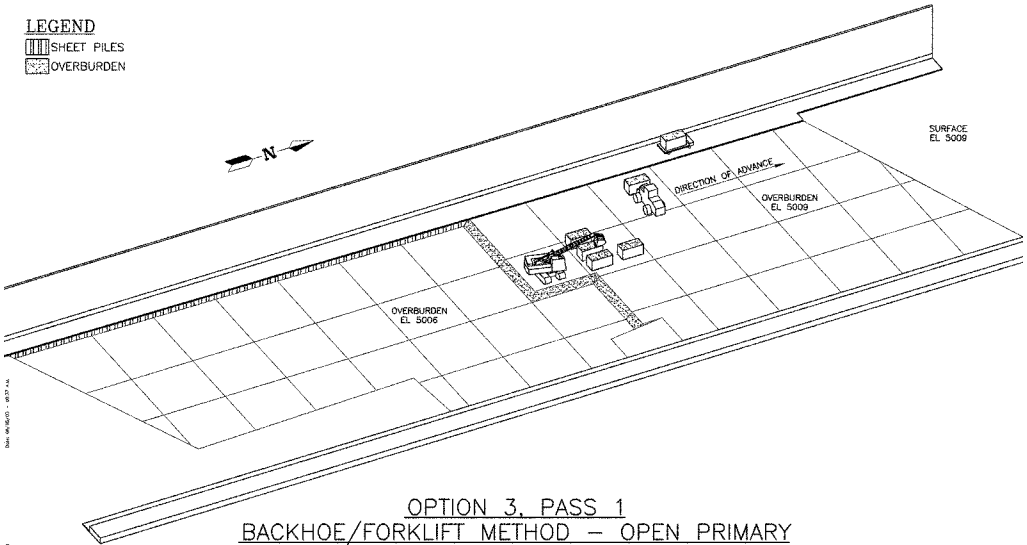
LEGEND
EARTH
SHEET PILES
OVERBURDEN
WASTE
UNDERBURDEN



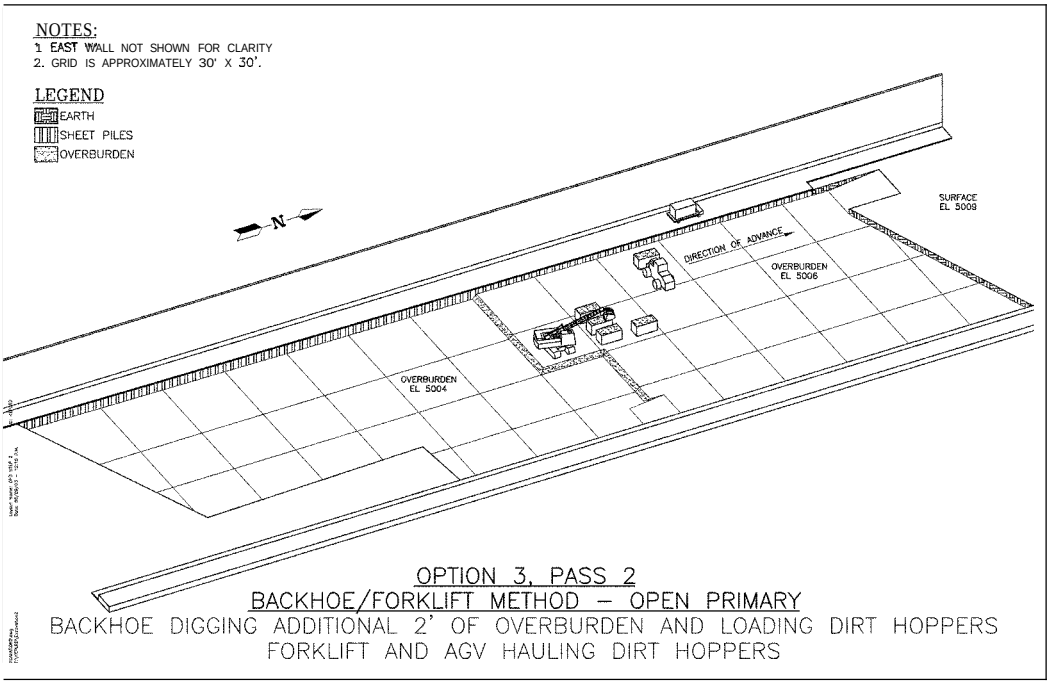
OPTION 2, PASS 3
FRONT-END-LOADER METHOD - OPEN PRIMARY
BACKHOE DIGGING AND PILING REMAINING OVERBURDEN
FRONT-END-LOADER DIGGING & HAULING WASTE & OVERBURDEN

NOTES:
1. EAST WALL NOT SHOWN FOR CLARITY.
2. GRID IS APPROXIMATELY 30' X 30'

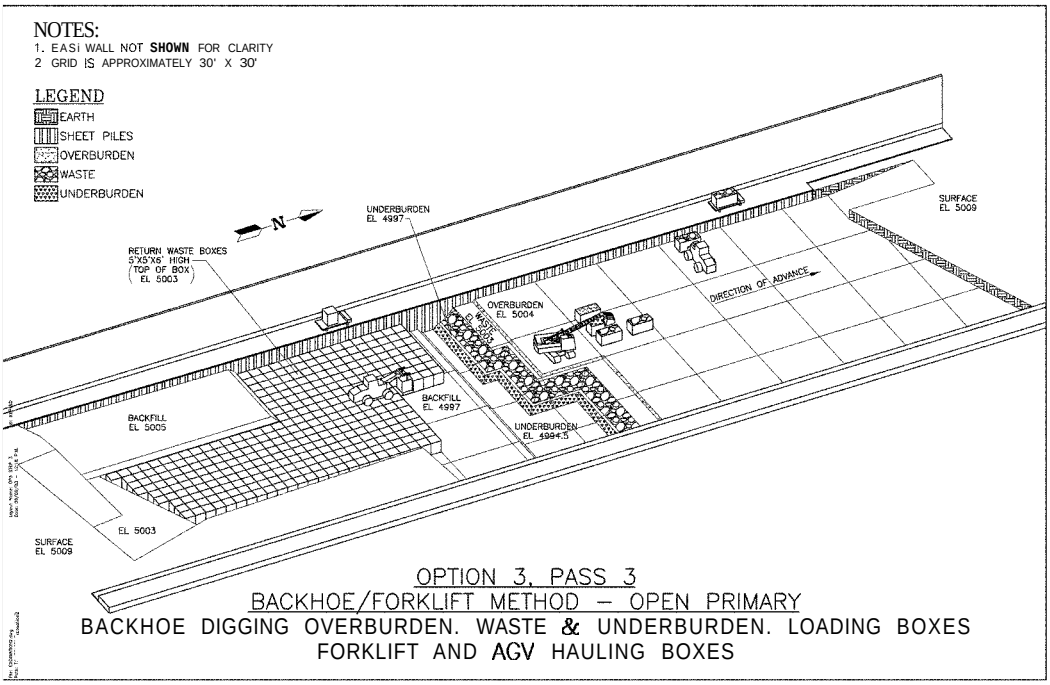
LEGEND
SHEET PILES
OVERBURDEN



OPTION 3, PASS 1
BACKHOE/FORKLIFT METHOD - OPEN PRIMARY
BACKHOE DIGGING TOP 3' OF OVERBURDEN AND LOADING DIRT HOPPERS
FORKLIFT AND AGV HAULING DIRT HOPPERS



OPTION 3, PASS 2
BACKHOE/FORKLIFT METHOD – OPEN PRIMARY
BACKHOE DIGGING ADDITIONAL 2' OF OVERBURDEN AND LOADING DIRT HOPPERS
FORKLIFT AND AGV HAULING DIRT HOPPERS



OPTION 3, PASS 3
BACKHOE/FORKLIFT METHOD – OPEN PRIMARY
BACKHOE DIGGING OVERBURDEN. WASTE & UNDERBURDEN. LOADING BOXES
FORKLIFT AND AGV HAULING BOXES

Appendix F3

Results Of Group Rating Of The Options Against The Criteria.

This table shows the average scores for each of the options within a criterion. The color of the cell indicates the level of consensus of the scores within that cell. A green cell indicates a high level of consensus and a red cell indicates a low level of consensus.

A consensus threshold value was set to help focus the group on those cells that had the most disagreement in the scores in the limited time available for discussion. It was not intended to imply that the group was in agreement on the score in that cell. The threshold level for consensus was set at 0.60.

Method:	Custom Method
Options:	Allow Bypass
Descriptions:	On a scale from 1 (low) to 7 (high), how well does this issue/alternative satisfy the goal?
Criteria:	Top Level Items = 20
Options:	Items = *3*
N:	11

	Option					
Criteria	**1**	**2**	**3**	**Total**	**Mean**	**STD**
1.Volume of difficult to retrieve waste left in the pit	5(5.18)	7(6.64)	4(4.36)	16.18	5(5.39)	1.15
2.Minimize contamination Spread to Clean Overburden or Maximize the amount of clean soil that can be retrieved.	7(6.55)	6(6.09)	6(6.36)	19.00	6(6.33)	0.23
3.Contamination Spread within Waste	6(5.91)	6(5.73)	6(5.55)	17.18	6(5.73)	0.18
4.Volume of Secondary Waste Generated	4(3.73)	7(6.82)	6(5.55)	16.09	5(5.36)	1.55
5.Contamination Levels of Secondary Wastes	7(6.82)	7(6.82)	7(6.82)	20.45	7(6.82)	0.00
6.Contamination Spread to Clean Underburden	6(6.27)	5(4.55)	6(5.73)	16.55	6(5.52)	0.88
7.Protection from Plutonium Uptake	6(6.36)	6(6.36)	5(5.45)	18.18	6(6.06)	0.52
8.Protection from Radiation	7(6.73)	7(6.82)	7(6.91)	20.45	7(6.82)	0.09
9.Protection from Hazardous Chemicals	7(6.73)	7(6.55)	6(6.18)	19.45	6(6.48)	0.28
10.Protection from Industrial Hazards	7(6.64)	7(6.55)	6(5.73)	18.91	6(6.30)	0.50
11.Designability	5(5.00)	7(6.91)	5(4.55)	16.45	5(5.48)	1.25
12.Constructability	5(5.18)	7(6.91)	6(5.55)	17.64	6(5.88)	0.91
13.Operability	6(6.09)	7(6.64)	5(5.27)	18.00	6(6.00)	0.69
14.Reliability	6(5.91)	7(6.82)	6(5.55)	18.27	6(6.09)	0.66
15.Flexibility	6(5.91)	6(6.09)	6(6.09)	18.09	6(6.03)	0.10
16.Maintainability	6(6.36)	6(6.09)	5(5.27)	17.73	6(5.91)	0.57
17.Inspectibiltiy	6(5.82)	7(7.00)	7(6.55)	19.36	6(6.45)	0.60
18.Operation risk (cost)	5(5.18)	7(7.00)	5(4.82)	17.00	6(5.67)	1.17
19.Deconability	5(4.91)	7(6.73)	5(5.45)	17.09	6(5.70)	0.93
20.Transferability to other pits and trenches	6(6.00)	7(6.55)	6(6.36)	18.91	6(6.30)	0.28
Total	117.27	129.64	114.09			
Mean	6(5.86)	6(6.48)	6(5.70)			
STD	0.79	0.57	0.69			

This table shows the distribution of scores (1-7) across the twenty criteria for each of the options. The number within a option/score cell indicates the number of participants that used that score for that option. Within a criterion, the options are sorted from the highest to the lowest score. Footnotes reference explanations provided by participants regarding why they scored a criteria/option combination.

	SCORE											
Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**Mean**	**STD**	**n**	**VCC**
1. Volume of difficult to retrieve waste left in the pit												
Option 2					1	2[3]	8	73	7(6.64)	0.67	11	0.78
Option 1			3[4]	1	2	1	4[5]	57	5(5.18)	1.72	11	0.43
Option 3	1[6]		2	2[7]	4	1	1	48	4(4.36)	1.63	11	0.46
2. Minimize contamination Spread to Clean Overburden or Maximize the amount of clean soil that can be retrieved.												
Option 1					2	1	8	72	7(6.55)	0.82	11	0.73
Option 3					2	3	6[8]	70	6(6.36)	0.81	11	0.73
Option 2					4	29	5	67	6(6.09)	0.94	11	0.69
3. Contamination Spread within Waste												
Option 1			1	1	2	1	6[10]	65	6(5.91)	1.45	11	0.52
Option 2			2		3		6[11]	63	6(5.73)	1.62	11	0.46

[3] This option provides the ability to move items using heavy equipment at side loads and allows the ability to dig lower than others since the equipment is in the waste.

[4] Hopper may limit size of object that can be relocated

[5] Overhead crane can remove large items. Front end loader is next best.

> Assume use of gantry crane With additional tools to lift some of the objects (e.g. clamshell, grapple)

> The crane has a 15 ton capacity. This provides the largest lifting capacity and highest variability for placing the moved item

[6] Tipping of the backhoe may become significant for opt. 3.

[7] Front end loader workmg in conjunction With the front end loader provides more ability to remove the waste dependent on size/configuration of objects.

[8] Use of boxes reduces the possibility of contaminating overburden

[9] Using the backhoe and placing the waste in containers to be lifted and transported by the crane would be a more precise and cleaner option due to use of backhoe and crane (not on soil). If the front-end loader is used to remove overburden, a larger amount of waste with each scoop (if contaminated) could result in a spread of contamination in the overburden.

[10] Top down approach reduce potential for mixing waste due to sloughing

[11] Mmimize handling steps and dumping options.

	SCORE											
Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**Mean**	**STD**	**n**	**VCC**
Option 3			1	1	4	1	4[12]	61	6(5.55)	1.37	11	0.54
4. Volume of Secondary Waste Generated												
Option 2					1		10[13]	75	7(6.82)	0.60	11	0.80
Option 3					7[14]	2	2	61	6(5.55)	0.82	11	0.73
Option 1	1[15]	2	4[16]		2[17]		2	41	4(3.73)	2.00	11	0.33
5. Contamination Levels of Secondary Wastes												
Option 3						2[18]	9	75	7(6.82)	0.40	11	0.87
Option 1					1		10	75	7(6.82)	0.60	11	0.80
Option 2					1[19]		10	75	7(6.82)	0.60	11	0.80
6.Contamination Spread to Clean Underburden												
Option 1			1		2		**8**	69	6(6.27)	1.35	11	0.55
Option 3		1			3[20]	3[21]	4	63	6(5.73)	1.49	11	0.50
Option 2			5[22]	1	2[23]		3	50	5(4.55)	1.75	11	0.42
7.Protection from Plutonium Uptake												

[12] Digging with the backhoe instead of digging with the front-end loader will provide ability to dig slower/more controlled and provides less chance of cross-contamination.

[13] Retrieval boxes become secondary waste

> This option does not use boxes, which should reduce the volume of waste.

[14] Volume of additional facility space is significant in option 1. Option 3 has additional material handling equipment that will require decontamination and maintenance.

[15] Bigger building and has the most equipment

[16] This option should be compared against the process flow diagram. Larger building would require more filters and thus, more secondary waste.

[17] Cranes are larger and should require more D&D items

[18] Has more wheeled vehicles, which provides larger chance of contamination spread.

[19] The vehicles are located in the waste and, as such, should be more contaminated.

[20] Wheeled vehicles are running on the underburden

[21] Option 1 has smaller chance of spreading contamination to the underburden due to reduced vehicle traffic on the surface.

[22] Bottom up has more potential to contaminate underburden.

> Loader traffic on underburden.

[23] Wheeled vehicles are running on the underburden

	SCORE											
Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**Mean**	**STD**	**n**	**VCC**
Option 2					2	3[24]	6	70	6(6.36)	0.81	11	0.73
Option 1					3[25]	1	7[26]	70	6(6.36)	0.92	11	0.69
Option 3		1[27]		1	2	5[28]	2	60	5(5.45)	1.44	11	0.52
8.Protection from Radiation												
Option 3						1	10	76	7(6.91)	0.30	11	0.90
Option 2					1		10	75	7(6.82)	0.60	11	0.80
Option 1					1	1	9	74	7(6.73)	0.65	11	0.78
9.Protection from Hazardous Chemicals												
Option 1					1	1	9[29]	74	7(6.73)	0.65	11	0.78
Option 2					1	3	7	72	7(6.55)	0.69	11	0.77
Option 3				1	2	2	6	68	6(6.18)	1.08	11	0.64
10.Protection from Industrial Hazards												
Option 1				1		1	9	73	7(6.64)	0.92	11	0.69
Option 2					2	1	8[30]	72	7(6.55)	0.82	11	0.73
Option 3			2	1	1	1	6	63	6(5.73)	1.68	11	0.44
11.Designability												
Option 2						1	10	76	7(6.91)	0.30	11	0.90
Option 1			1[31]	3	4	1	2	55	5(5.00)	1.26	11	0.58

[24] Has more equipment capable of breaching confinement

> Frequency of maintenance is comparable to Opt-1. Risk of breaching confinement slightly higher than crane

[25] Less equipment used in option 2 provides less probability of making an entry into the confinement. Ability to remove the equipment from the confinement remotely is important.

[26] The number of equipment located in the pit is lower and should reduce the times that you would have to send a person into an uncontrolled section of the containment.

[27] Many more systems in confinement. Also many of these items are more complex increasing probability of failure

[28] Has more equipment capable of breaching confinement

[29] We're remediating Pu and very toxic chemicals. I don't think we should be discriminating on hydraulic fluid!

> Has a lower number of fossil fuel burning vehicles

[30] Option 3 with additional equipment operating provides more potential for industrial injury during manned entry.

[31] More equipment in options 1 and 3

	SCORE											
Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**Mean**	**STD**	**n**	**VCC**
Option 3	1	1	1		5[32]	2	1	50	5(4.55)	1.81	11	0.40
12.Constructability												
Option 2						1	10	76	7(6.91)	0.30	11	0.90
Option 3		1		1	3[33]	2	4	61	6(5.55)	1.57	11	0.48
Option 1			1[31]	2	4	2	2	57	5(5.18)	1.25	11	0.58
13.Operability												
Option 2					2[34]		9	73	7(6.64)	0.81	11	0.73
Option 1			1[31]		2	2	6[35]	67	6(6.09)	1.30	11	0.57
Option 3			1	2[36]	3[31]	3	2	58	5(5.27)	1.27	11	0.58
14.Reliability												
Option 2					1		10	75	7(6.82)	0.60	11	0.80
Option 1			1[31]		3	2	5	65	6(5.91)	1.30	11	0.57
Option 3				1	5[31]	3	2	61	6(5.55)	0.93	11	0.69
15.Flexibility												
Option 3					4[31]	2	5	67	6(6.09)	0.94	11	0.69
Option 2				1	3	1	6	67	6(6.09)	1.14	11	0.62
Option 1			1[31]		3[37]	2	5[38]	65	6(5.91)	1.30	11	0.57
16.Maintainability												

[32] More equipment in options 1 and 3

> Option 1 has crane and larger facility. Option 3 has more equipment and systems to integrate

[33] More equipment in options 1 and 3

> Option 1- Crane makes facility lager and more difficult to construct. Option 3 has more systems to be installed. Option 2 is simpler in concept so easier to construct.

[34] Don't like loader on underburden in dig face, workmg around large objects and on waste post-overburden removal. Gantry crane of option 1 appears to provide cleaner, more flexible options if deploy a few tools from crane.

[35] Options 1 and 2 would be less complex to operate simultaneously. Fewer interfacing equipment reduces operability complexity.

[36] The return to pit approach on this option is problematic due to load considerations and cross contamination of returned boxes.

[37] Option 1 doesn't allow as many options to handle odd situations. Other options using front end loader in the confinement provides additional flexibility for material handling.

[38] This option appears to be most flexible if deploy some tools from gantry crane as well as backhoe. Option could include loader as well if problems arise. Also, appears a front end loader could be used as part of this option if warranted during retrieval.

	SCORE											
Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**Mean**	**STD**	**n**	**VCC**
Option 1			1[31]			3	7	70	6(6.36)	1.21	11	0.60
Option 2					4	2	5	67	6(6.09)	0.94	11	0.69
Option 3			1	2	3[31]	3	2	58	5(5.27)	1.27	11	0.58
17.Inspectibiltiy												
Option 2							11	77	7(7.00)	0.00	11	1.00
Option 3					2[31]	1	8	72	7(6.55)	0.82	11	0.73
Option 1			1[31]	1	2[39]	2	5[40]	64	6(5.82)	1.40	11	0.53
18.Operation risk (cost)												
Option 2							11	77	7(7.00)	0.00	11	1.00
Option 1			1	1	6[41]	1	2	57	5(5.18)	1.17	11	0.61
Option 3		1[42]	3		2[31]	3	2	53	5(4.82)	1.78	11	0.41
19.Deconability												
Option 2					1	1	9[43]	74	7(6.73)	0.65	11	0.78
Option 3			1		5[31]	3	2	60	5(5.45)	1.13	11	0.62
Option 1			4[31]	1	1	2	3	54	5(4.91)	1.76	11	0.41
20.Transferability to other pits and trenches												
Option 2					1	3	7	72	7(6.55)	0.69	11	0.77
Option 3					3	1	7	70	6(6.36)	0.92	11	0.69
Option 1			1	1	1[44]	2	6	66	6(6.00)	1.41	11	0.53

[39] Option 1 overhead crane requires inspection and load testing that will be a challenge compared to the other options.

[40] I could not differentiate between Maintainability and Inspectability at this level of detail. Therefore I disregarded this category.

[41] More equipment in options 1 and 3.

> Operation on top of waste could result in subsidence or damage to equipment due to dropping over the edge. Option 2 provides for the operation of the equipment from underburden surface possibility instead of working with backhoe from the top of the waste. Option 2 cuts down operational cost due to larger bucket on front end loader.

[42] Forklift operating on 1 foot overburden

[43] Additional space and surface area inside building and required decontamination of all the surfaces increased with option 1

[44] The ability to design and transfer concept is easiest with the more flexible concept such as using mobile equipment. The crane offers challenge due to re-design issues associated with loading on frame based on crane width and weight.

This table shows the distribution of scores (1–7) across the three criteria for each of the criteria. The number within a criteria/score cell indicates the number of participants that used that score for that criterion. Within an option, the criteria are sorted from the highest to the lowest score

	Score											
Critcria	1	2	3	4	5	6	7	Total	Mean	STD	n	VCC
Option 1												
Contamination Levels of Secondary Wastes					1		10	75	7(6 82)	0 60	11	0 80
Protection from Radiation					1	1	9	74	7(6 73)	0 65	11	0 78
Protection from Hazardous Chemicals					1	1	9	74	7(6 73)	0 65	11	0 78
Protection from Industrial Hazards				1		1	9	73	7(6 64)	0 92	11	0 69
Minimize contamination Spread to Clean Overburden or Maximize the amount of clean soil that can be retrieved.					2	1	8	72	7(6.55)	0.82	11	0.73
Protection from Plutonium Uptake					3	1	7	70	6(6.36)	0.92	11	0.69
Maintainability			1			3	7	70	6(6.36)	1.21	11	0.60
Contamination Spread to Clean Underburden			1		2		8	69	6(6.27)	1.35	11	0.55
Operability			1		2	2	6	67	6(6.09)	1.30	11	0.57
Transferability to other pits and trenches			1	1	1	2	6	66	6(6.00)	1.41	11	0.53
Reliability			1		3	2	5	65	6(5.91)	1.30	11	0.57
Flexibility			1		3	2	5	65	6(5.91)	1.30	11	0.57
Contamination Spread within Waste			1	1	2	1	6	65	6(5.91)	1.45	11	0.52
Inspectability			1	1	2	2	5	64	6(5.82)	1.40	11	0.53
Operation risk (cost)			1	1	6	1	2	57	5(5.18)	1.17	11	0.61
Constructability			1	2	4	2	2	57	5(5.18)	1.25	11	0.58
Volume of difficult to retrieve waste left in the pit			3	1	2	1	4	57	5(5.18)	1.72	11	0.43
Designability			1	3	4	1	2	55	5(5.00)	1.26	11	0.58
Deconability			4	1	1	2	3	54	5(4.91)	1.76	11	0.41
Volume of Secondary Waste Generated	1	2	4		2		2	41	4(3.73)	2.00	11	0.33

Criteria	Score 1	2	3	4	5	6	7	Total	Mean	STD	n	VCC
Option 2												
Inspectability							11	77	7(7.00)	0 00	11	1.00
Operation risk (cost)							11	77	7(7.00)	0 00	11	1.00
Designability						1	10	76	716.91)	0 30	11	0.90
Constructability						1	10	76	7(6.91)	0.30	11	0.90
Volume of Secondary Waste Generated					1		10	75	7(6.82)	0.60	11	0.80
Contamination Levels of Secondary Wastes					1		10	75	7(6.82)	0.60	11	0.80
Protection from Radiation					1		10	75	7(6.82)	0.60	11	0.80
Reliability					1		10	75	7(6.82)	0.60	11	0.80
Deconability					1	1	9	74	7(6.73)	0.65	11	0.78
Volume of difficult to retrieve waste left in the pit					1	2	8	73	7(6.64)	0.67	11	0.78
Operability					2		9	73	7(6.64)	0.81	11	0.73
Protection from Hazardous Chemicals					1	3	7	72	7(6.55)	0.69	11	0.77
Transferability to other pits and trenches					1	3	7	72	7(6.55)	0.69	11	0.77
Protection from Industrial Hazards					2	1	**8**	72	7(6.55)	0.82	11	0.73
Protection from Plutonium Uptake					2	3	6	70	6(6.36)	0.81	11	0.73
Minimize contamination Spread to Clean Overburden or Maximize the amount of clean soil that can be retrieved.					4	2	5	67	6(6.09)	0.94	11	0.69
Maintainability					4	2	5	67	6(6.09)	0.94	11	0.69
Flexibility				1	3	1	6	67	6(6.09)	1.14	11	0.62
Contamination Spread within Waste			2		3		6	63	6(5.73)	1.62	11	0.46
Contamination Spread to Clean Underburden			5	1	2		3	50	5(4.55)	175	11	0.42
Option 3												
Protection from Radiation						1	10	76	7(6.91)	0 30	11	0.90
Contamination Levels of Secondary Wastes						2	9	75	7(6.82)	0 40	11	0.87
Inspectability					2	1	8	72	7(6.55)	0.82	11	0.73
Minimize contamination					2	3	6	70	616.36)	0.81	11	0.73

	Score											
Criteria	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**Mean**	**STD**	**n**	**VCC**
Spread to Clean Overburden or Maximize the amount of clean soil that can be retrieved.												
Transferability to other pits and trenches					3	1	7	70	6(6.36)	0.92	11	0.69
Protection from Hazardous Chemicals				1	2	2	6	68	6(6.18)	1.08	11	0.64
Flexibility					4	2	5	67	6(6.09)	0.94	11	0.69
Contamination Spread to Clean Underburden		1			3	3	4	63	6(5.73)	1.49	11	0.50
Protection from Industrial Hazards			2	1	1	1	6	63	6(5.73)	1.68	11	0.44
Volume of Secondary Waste Generated					7	2	2	61	6(5.55)	0.82	11	0.73
Reliability				1	5	3	2	61	6(5.55)	0.93	11	0.69
Contamination Spread within Waste			1	1	4	1	4	61	6(5.55)	1.37	11	0.54
Constructability		1		1	3	2	4	61	6(5.55)	1.57	11	0.48
Deconability			1		5	3	2	60	5(5.45)	1.13	11	0.62
Protection from Plutonium Uptake		1		1	2	5	2	60	5(5.45)	1.44	11	0.52
Operability			1	2	3	3	2	58	5(5.27)	1.27	11	0.58
Maintainability			1	2	3	3	2	58	5(5.27)	1.27	11	0.58
Operation risk (cost)		1	3		2	3	2	53	5(4.82)	1.78	11	0.41
Designability	1	1	1		5	2	1	50	5(4.55)	1.81	11	0.40
Volume of difficult to retrieve waste left in the pit	1		2	2	4	1	1	48	4(4.36)	1.63	11	0.46

Comments Recorded During Discussion Of Selection Criteria

1. Volume of difficult to retrieve waste left in the pit

    a. The best alternative will minimize the volume of waste in the pit that can't be taken out of the pit because it is too large or too hot or removal of the waste is too complicated.

2. Minimize contamination Spread to Clean Overburden or Maximize the amount of clean soil that can be retrieved.

    a. The best option will avoid spreading contamination of overburden (top 6 feet) to the rest of the pit. Clean overburden is separated into the top 5 feet and then the remaining 1 ft of overburden. An alternative view may be the option that maximizes the amount of clean overburden at the end of operations.

    b. Will handling the material more cause a higher potential of the overburden to be contaminated.

    c. Maximize the amount of clean soil that can be retrieved

3. Contamination Spread within Waste

    a. The best option will be the one that stirs and mixes the waste the least as it is being removed from the pit.

    b. Includes digging and transporting it to the deck.

4. Volume of Secondary Waste Generated

    a. The best option will minimize the volume of secondary waste.

    b. Vehicles, hoppers, personal protective equipment, equipment and size of confinement building.

    c. The cranes will become waste

    d. Opt 1 will require more HEPA filters to be disposed.

5. Contamination Levels of Secondary Wastes

    a. The best option has a lower level of secondary waste

    b. The waste boxes are not considered secondary waste. The hopper boxes are secondary waste.

6. Contamination Spread to Clean Underburden

    a. The best option minimizes the spread of waste to the underburden.

b. This includes the underburden removed, left in place and the new underburden put back into the pit.

7. Protection from Plutonium Uptake

   a. The best option minimizes the uptake of P

   b. Maintaining confinement and reduced need to send in workers are the key factors

   c. Number of elements in confinement and the complexity of the elements are key.

   d. Can the equipment free wheel, or are the brakes set when the machine is in N?

8. Protection from Radiation

   a. The best option is the one that minimizes the exposure to the source.

   b. Is the control room far enough away from the operations

9. Protection from Hazardous Chemicals

   a. The best option minimizes the amount of operational fluids

10. Protection from Industrial Hazards

   a. The best option will be the one that reduces the number and amount of equipment movement. This includes fire hazards.

   b. Batteries in the AGVs will be hazards. An option may be an energized rail.

   c. Maintenance activities are a key factor.

   d. Eliminating the lead in the batteries eliminates the mixed waste stream.

11. Designability

   a. The best option minimizes the design challenges and the size of the sales job you have to do on the design. Includes cost of design, number of mockups to prove feasibility, risks of design.

   b. Includes the complexity of the design.

   c. Number of systems that have to be integrated is a key.

12. Constructability

   a. The best option will be the simplest to build

13. Operability
    a. SO testing is done at this stage.

    b. The best option is the one that is the easiest to operate. Things work well and don't take a large crew to do.

    c. Option 1 initially required more operators because of the number and varied pieces of equipment. This may no longer be the case. One shift was estimated at 27 people.

    d. Industrial safety oversight will be about the same for all three options.

    e. Storage of boxes to provide enough room for the machines to operate is an operations issue.

14. Reliability

    a. The best option is the most reliable and will have the least down time.

    b. Need to get reliability data from the equipment manufacturer and possible re-rank based on real data.

15. Flexibility

    a. The best option is the one that can be changed on the fly once operations start and you run into problems. Can adapt to changes or easily recover from problems.

    b. The ability to go outside the plan and still make it work.

16. 16. Maintainability

    a. The best option is the one that is the easiest (least complex) and the fewest maintenance activities.

    b. Includes maintenance and repair of the equipment.

    c. The level of maintenance may depend on the end use of the equipment (reuse or dispose) and the risk of failure dependent on the end use.

17. Inspectability

    a. The best option is the one that is easiest to get to look at equipment or anything else that you need to verify.

    b. Includes inspecting equipment, boxes, weld joints, or other material.

    c. Will have to prepare a hostile environment plan for inspections.

    d. The number of things to inspect, the frequency of inspection and the difficulty of doing the inspection are key factors.

e. The containment skin and the anti collision equipment are safety significant.

18. Operation risk (cost)

a. The best option is the one that has the lease chance of downtime of something going wrong and the cost to recover from the mistake.

b. An example is if the backhoe tips over the pit edge and you have to recover the backhoe.

c. May also include the obstacles down in the pit.

d. Costs associated with off normal events and recovering from those events.

19. Deconability

a. The best option is the one that is the easiest to decontaminate and results in the least amount of residual contamination.

b. This is a function of the number of equipment pieces and the amount of the surface area that can be contaminated.

c. May depend on the end use of the equipment (reuse or dispose and type of disposal).

20. Transferability to other pits and trenches

a. The best option is the one that the design and method can be used on the other pits and trenches, not necessarily the transfer of the actual equipment.